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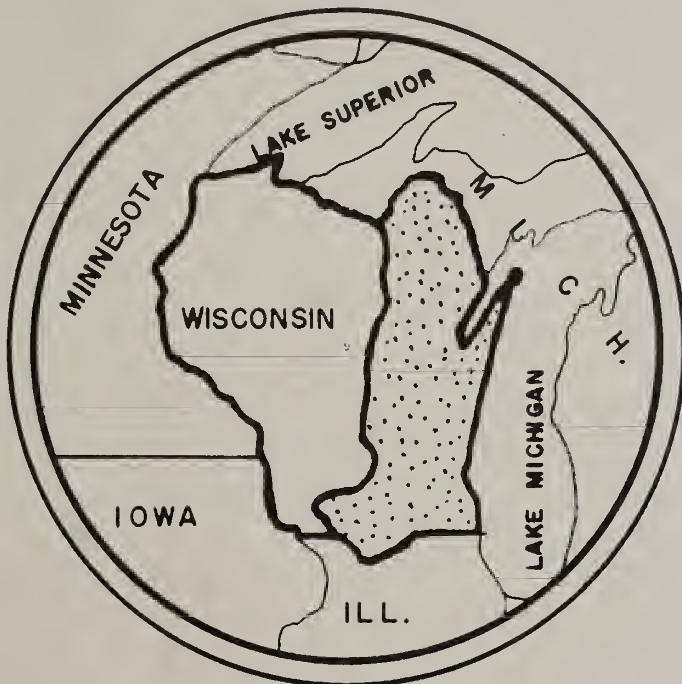
COMPARATIVE METHODS OF DETERMINING CROPLAND SOIL LOSSES IN IOWA COUNTY, WISCONSIN



TECHNICAL REPORT NO. 2

WORKING MATERIAL FOR

SOUTHEAST WISCONSIN RIVERS BASIN

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
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JANUARY 1969

COMPARATIVE METHODS OF DETERMINING

CROPLAND SOIL LOSSES IN IOWA COUNTY, WISCONSIN

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ABSTRACT

Using the farm plans of cooperators with the Iowa County, Wisconsin Soil and Water Conservation District, computations were made of gross upland sheet erosion from 724 acres of cropland behind structure site 2, Otter Creek Watershed.

Two comparative methods of determining soil loss were used; the modified Musgrave Equation - abbreviated MSPC, and the Universal Soil Loss Equation - abbreviated USLE. Both equations were adapted to local conditions.

Class I, II, and III cropland averaged a soil loss in tons per acre 1.76 times greater when the MSPC method was used. In Class IV and VI cropland, six of ten examples averaged a soil loss in tons per acre 1.36 times greater using the MSPC equation. In four examples of Class IV sets, the USLE equation yielded a soil loss in tons per acre 0.83 times greater than by use of the MSPC equation.

The author believes that the modified Musgrave Equation is more suitable and accurate for watershed areas in which relief is greater than 200 feet, Class I to Class VI soils are cropped, and where slopes, practices, and rotations are quite diverse.

Introduction

Within the Iowa County portion of the Driftless Area, Wisconsin, there are no natural lakes, no farm ponds controlling large drainage areas, and no man-made lakes that have had reservoir sediment surveys.

In order to determine sediment storage requirements for single and multiple-purpose floodwater retarding structures in the small watersheds program (P.L.-566), it has been necessary to compute gross upland sheet erosion by some regional and empirical method.

For the past decade in Wisconsin sediment storage requirements for all P.L.-566 structures have been determined by a modified Musgrave formula suitable for the "Cornbelt Area".

Since 1962, the Universal Soil Loss Equation developed by Wischmeier et. al. has also been used in Wisconsin.

In order to compare soil loss from upland sheet erosion by the modified Musgrave Equation - abbreviated MSPC, and the Universal Soil Loss Equation - abbreviated USLE, a detailed study was made of cooperator cropland behind Site 2, Otter Creek Watershed, Iowa County, Wisconsin.

The author, and Mr. K.D. Halverson, District Conservationist, Waupaca County, Wisconsin, collected data from cooperator farm plans, and contact aerial photographs of the area. Additional information was obtained from Mr. C.O. Tarrence, District Conservationist, Iowa County. Computations for the modified Musgrave Equation were made by the author using directions and factors in the Ghormley memorandum of 1/4/56 - "Allocation of Sediment Storage for Design of Floodwater Retarding Structures", Soil Conservation Service, United States Department of Agriculture. Mr. K.D. Halverson made computations for the Universal Soil Loss Equation with factors adjusted for Iowa County and the State of Wisconsin.

Location

Site 2 is in the NW$\frac{1}{2}$, Section 35, T. 8 N., R. 1 E., Morrey Creek, Iowa County, Wisconsin. The watershed behind the site has a drainage area of 2,976 acres or 4.65 square miles. The site is 20 miles north-northwest of the county seat, Dodgeville. Dodgeville is 42 miles southwest of Madison, Wisconsin. The area is included in Economic Subarea 5 of the Southeast Wisconsin Rivers Basin.

Climate

The watershed has a humid continental climate with wide extremes of temperature. The coldest month is January with an average temperature of

16° F. July, the warmest month, has an average temperature of 72° F. Length of growing season is close to 120 days. The average rainfall is 31 inches, and occurs mainly during the growing season. Average snowfall is 39 inches, occuring from November through March.

Physiography

Site 2 is within the "Driftless Area" of Wisconsin, a rather well defined region of accentuated relief, stream erosion, and weathering. It is a part of the Upper Mississippi River Drainage Basin.

The watershed is roughly oval in shape with a maximum relief of 400 feet - from 800 feet MSL, at dam site to 1,200 feet MSL on the ridgeland. The relief ratio is $\frac{400}{13,200}$ or 0.03. The area is in late youth or early maturity.

Soils

About ninety percent of the watershed soils are dark-colored deep silty soils on gently sloping uplands. Some eight percent of the soils are light-colored moderately deep to thin soils on rolling uplands and valley slopes. The remaining soils are loamy to sandy soils on floodplain and terrace, and steep stony or rocky land.

Cropland soils are as follows: 1/

Arenzville silt loam - Class I
Dunbarton silt loam - Class IIIel, IVel, and IVe2
Fayette silt loam - Class IIel, IIIel, and VIel
Huntsville silt loam - Class I
Palsgrove silt loam - Class IIel, IIIel, and IVel

Geology

Cambrian and Ordovician rocks outcrop in the watershed, but are mostly obscured by recent soils, colluvium, and alluvium. The Ordovician formations are predominantly dolomites and sandstones. The Cambrian formations are composed of sandstones, greensands, and minor amounts of shale, siltstone, and conglomerate. The strata are nearly horizontal but dip slightly to the southwest. No faults or folds were observed.

1/ Soil Survey - Iowa County, Wisconsin, Series 1958, No. 22, July 1962, used Shallow Dubuque now named Dunbarton, and Deep Dubuque now named Palsgrove.

Land Use

Land use behind Site 2, is as follows:

Cropland	Acres	Percent
Cropland	1,159	39
Pasture	1,244	42
Woodland & Wildlife	469	16
Roads, Bldg., Other	104	3
	2,976	100

Methodology

Thirteen cooperators with the Iowa County Soil and Water Conservation District, own 724 acres of cropland ranging in capability from Class I to Class VIel. Using all cooperator cropland, computations were made using the modified Musgrave formula (MSPC) with cropping pattern, practice, percent slope, length of slope, area, and soil factors considered. A management factor is then applied.

The Universal Soil Loss Equation computations used rainfall erosion, soil, cropping-management factor, length of slope, steepness of slope, and erosion control practice factors.

The results are shown in tabular form by capability unit, soil type, cropping pattern, practice, percent and length of slope, and soil loss in tons per acre per year. The two methods are indicated in pairs - the USLE data preceding the MSPC.

Results

Averaging the USLE and MSPC pairs or sets in each capability unit with the same soil type, cropping pattern, practice, percent of slope and length of slope gave the following results:

Class I	Two sets; soil losses in tons per acre were 1.9 times greater using the MSPC method.
Class IIel	Seventeen sets; soil losses in tons per acre were 1.8 times greater using the MSPC method.
Class IIIel	Fourteen sets; soil losses in tons per acre were 1.6 times greater using the MSPC method.

Class IVe1	Two sets; soil losses in tons per acre were 1.2 times greater using the MSPC method.
Class IVe2	Three sets; soil losses in tons per acre were 1.5 times greater using the MSPC method.
Class VIe1	One set; soil losses in tons per acre were 1.4 times greater using the MSPC method.

Exceptions occurred in three sets of Class IVe1, where soil losses in tons per acre averaged 0.80 times greater using the USLE formula.

A Dunbarton silt loam, Class IVe2, with an RO2H rotation, contour strip-cropped, and a 15 percent slope had a soil loss in tons per acre 0.93 times greater when using the USLE formula.

Conclusions

Even with excellent management, practices, and rotations, there are significant differences in results when computing gross upland sheet erosion soil losses on cropland by the modified Musgrave Equation and the Universal Soil Loss Equation.

Class I, II, and III land which is most suitable for cropping averaged a soil loss 1.76 times greater when the MSPC method was used. In Class IV, and VI cropland, six sets averaged a soil loss 1.36 times greater when the MSPC method was used. In four sets of Class IV land a reverse situation showed that soil losses as computed by the USLE averaged 0.83 times greater than when computed by the MSPC method.

Considering that in areas where reservoir survey information is lacking these computations are the first step in a series of steps to determine sediment storage requirements, it is imperative that the most accurate method be used for efficiency and economy of structure design.

The author believes that the modified Musgrave Equation is more suitable and accurate for the Driftless Area of Wisconsin where relief is great, Class I to Class VI soils are cropped, there is much cross-slope cultivation, and there exists a diversity of soils, slopes, practices, and rotations.

SUMMARY SHEET OF SOIL LOSSES CLASS I AND IIel LAND

Capability Unit	Soil Type	Cropping Pattern	Practice	SLOPE %	SLOPE Length	Soil Loss Tons / Ac. Per Year
I						
USLE	Huntsville	RROHH	None	1	200	0.58
MSPC	Huntsville	RROHH	None	"	"	1.09
USLE	Arenzville	RROHH	None	"	"	0.58
MSPC	Arenzville	RROHH	None	"	"	1.09
IIel						
USLE	Fayette	RO~~OH~~ 2H	CSC	5	300	0.80
MSPC	Fayette	RO2H	CSC	"	"	1.43
USLE	Fayette	RO3H	CSC	8	300	1.75
MSPC	Fayette	RO3H	CSC	"	"	2.57
USLE	Fayette	RO2H	CSC	4	200	0.64
MSPC	Fayette	RO2H	CSC	"	"	1.13
USLE	Fayette	RO2H	CSC	4	400	0.90
MSPC	Fayette	RO2H	CSC	"	"	1.71
USLE	Fayette	RO2H	Contour	3	250	1.10
MSPC	Fayette	RO2H	Contour	"	"	1.78
USLE	Fayette	RO2H	Contour	4	250	1.40
MSPC	Fayette	RO2H	Contour	"	"	2.62
USLE	Palsgrove	RO3H	CSC	8	150	1.25
MSPC	Palsgrove	RO3H	CSC	"	"	1.69

SUMMARY SHEET OF SOIL LOSSES CLASS IIel LAND

Capability Unit	Soil Type	Cropping Pattern	Practice	SLOPE		Soil Loss Tons / Ac. Per Year
				%	Length	
IIel						
USLE	Palsgrove	RO3H	CSC	4	100	0.34
MSPC	Palsgrove	RO3H	CSC	"	"	0.52
USLE	Palsgrove	RO2H	CSC	5	200	0.82
MSPC	Palsgrove	RO2H	CSC	"	"	1.51
USLE	Palsgrove	RO3H	CSC	5	200	0.66
MSPC	Palsgrove	RO3H	CSC	"	"	1.12
USLE	Palsgrove	RO2H	Contour	8	250	4.00
MSPC	Palsgrove	RO2H	Contour	"	"	9.31
USLE	Palsgrove	RO2H	CSC	4	200	0.63
MSPC	Palsgrove	RO2H	CSC	"	"	1.13
USLE	Palsgrove	RO2H	CSC	8	200	1.75
MSPC	Palsgrove	RO2H	CSC	"	"	2.90
USLE	Palsgrove	RO2H	CSC	6	500	1.60
MSPC	Palsgrove	RO2H	CSC	"	"	3.39
USLE	Palsgrove	5H	CSC	6	500	0.14
MSPC	Palsgrove	5H	CSC	"	"	0.31
USLE	Palsgrove	RO2H	CSC	7	200	1.25
MSPC	Palsgrove	RO2H	CSC	"	"	2.41

SUMMARY SHEET OF SOIL LOSSES CLASS IIe1 AND IIIe1 LAND

Capa-bility Unit	Soil Type	Cropping Pattern	Practice	SLOPE %	SLOPE Length	Soil Loss Tons / Ac. Per Year
IIe1						
USLE	Palsgrove	RO2H	Contour	5	250	1.80
MSPC	Palsgrove	RO2H	Contour	"	"	3.55
IIIe1						
USLE	Fayette	RO3H	CSC	12	250	2.95
MSPC	Fayette	RO3H	CSC	"	"	3.97
USLE	Fayette	RO2H	CSC	9	200	2.10
MSPC	Fayette	RO2H	CSC	"	"	3.39
USLE	Fayette	RO2H	Contour	12	200	6.40
MSPC	Fayette	RO2H	Contour	"	"	14.09
USLE	Dunbarton	RO3H	CSC	10	150	1.70
MSPC	Dunbarton	RO3H	CSC	"	"	2.28
USLE	Dunbarton	RO3H	Contour	8	200	2.9
MSPC	Dunbarton	RO3H	Contour	"	"	3.69
USLE	Dunbarton	RO3H	CSC	12	350	3.40
MSPC	Dunbarton	RO3H	CSC	"	"	4.87
USLE	Dunbarton	RO2H	Contour	12	200	6.40
MSPC	Dunbarton	RO2H	Contour	"	"	14.09
USLE	Dunbarton	RO2H	CSC	12	200	3.25
MSPC	Dunbarton	RO2H	CSC	"	"	5.00

SUMMARY SHEET OF SOIL LOSSES CLASS IIIel AND IVel LAND

Capa-bility Unit	Soil Type	Cropping Pattern	Practice	SLOPE		Soil Loss Tons / Ac. Per Year
				%	Length	
IIIel						
USLE	Dunbarton	RO2H	CSC	8	200	1.75
MSPC	Dunbarton	RO2H	CSC	"	"	2.90
USLE	Palsgrove	RO2H	CSC	8	200	1.75
MSPC	Palsgrove	RO2H	CSC	"	"	2.90
USLE	Palsgrove	RO3H	CSC	12	350	3.50
MSPC	Palsgrove	RO3H	CSC	"	"	4.87
USLE	Palsgrove	RO2H	Contour	12	200	6.50
MSPC	Palsgrove	RO2H	Contour	"	"	14.09
USLE	Palsgrove	RO3H	Contour	6	200	1.65
MSPC	Palsgrove	RO3H	Contour	"	"	2.72
USLE	Palsgrove	RO2H	CSC	12	200	3.20
MSPC	Palsgrove	RO2H	CSC	"	"	5.00
IVel						
USLE	Dunbarton	RO3H	CSC	13	150	4.30
MSPC	Dunbarton	RO3H	CSC	"	"	3.26
USLE	Dunbarton	RO3H	Contour	18	150	16.25
MSPC	Dunbarton	RO3H	Contour	"	"	14.28
USLE	Palsgrove	RO2H	CSC	12	150	3.50
MSPC	Palsgrove	RO2H	CSC	"	"	4.20

SUMMARY SHEET OF SOIL LOSSES CLASS IVel, IVe2 AND VIel LAND

Capability Unit	Soil Type	Cropping Pattern	Practice	SLOPE		Soil Loss Tons / Ac. Per Year
				%	Length	
IVel						
USLE	Palsgrove	RO3H	CSC	17	200	7.60
MSPC	Palsgrove	RO3H	CSC	"	"	5.58
USLE	Palsgrove	RO2H	CSC	12	200	4.05
MSPC	Palsgrove	RO2H	CSC	"	"	5.00
IVe2						
USLE	Dunbarton	RO3H	Contour	12	200	6.50
MSPC	Dunbarton	RO3H	Contour	"	"	12.48
USLE	Dunbarton	RO3H	CSC	12	200	3.25
MSPC	Dunbarton	RO3H	CSC	"	"	3.62
USLE	Dunbarton	RO3H	Contour	16	200	13.75
MSPC	Dunbarton	RO3H	Contour	"	"	18.22
USLE	Dunbarton	RO2H	CSC	15	200	7.60
MSPC	Dunbarton	RO2H	CSC	"	"	7.03
VIel						
USLE	Fayette	RROHH	Contour	20	100	31.50
MSPC	Fayette	RROHH	Contour	"	"	43.39

LEGEND

R ----- corn
O ----- oats
H ----- hay

Contour ----- farming on the contour
CSC --------- contour stripcropping
None -------- up and down hill cultivation

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